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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/092,158	06/05/1998	SAILESH M. MERCHANT	MERCHANT3333	5736
27964	7590	02/12/2004	EXAMINER	
HITT GAINES P.C. P.O. BOX 832570 RICHARDSON, TX 75083			MALDONADO, JULIO J	
			ART UNIT	PAPER NUMBER
			2823	
DATE MAILED: 02/12/2004				

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/092,158

Applicant(s)

MERCHANT ET AL.

Examiner

Julio J. Maldonado

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 17 November 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,4-12 and 15-24 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,4-12 and 15-24 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.
a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 20031113. 6) ☐ Other: _____

DETAILED ACTION

1. The rejection as set forth in paper mailed on 09/05/2003 is withdrawn in view of applicants' amendments.
2. A new rejection is included in this action.
3. Claims 1, 4-12 and 15-24 are pending in the application.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1, 5, 6-12, 16, 17-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (U.S. 5,591,671) in view of Bai et al. (U.S. 5,714,418) and Teo (U.S. 5,970,374).

In reference to claims 1, 7, 12, 18 and 24, Kim et al. (Figs.2-4) in a related method to form an interconnect layer teach the steps of forming a contact opening (25) in a dielectric layer (24) on a semiconductor substrate (21, 24), said contact opening (25) electrically contacting an active device; depositing by physical vapor deposition (PVD) a barrier layer (26, 27) in said contact opening (25) and on at least a portion of said semiconductor substrate (21, 24), said barrier layer deposition step includes depositing titanium layer (26) and depositing titanium nitride layer (27) on said titanium layer (26); depositing a contact metal (28) on said barrier layer (26, 27) within said contact opening (25); removing a substantial portion of said contact metal (28) and said

barrier layer (26, 27) from said semiconductor substrate (21, 24) to form a contact plug within said contact opening (25); and subjecting said contact plug to a heating treatment, changing the crystalline structure (i.e., annealing) of the barrier layer (26, 27) to reduce ohmic contact (column 4, line 27 – column 6, line 56).

Kim et al. fail to show extending the plug to an uppermost surface of said substrate. However, Bai et al. (Figs.4C-4D) in a related method to form planarized interconnects in a semiconductor device teach the steps of removing a substantial portion a contact metal (44) and a barrier layer (42, 43) from a semiconductor substrate (40, 41) to form a contact plug within a contact opening (47), said plug extending to an uppermost surface of said substrate (40, 41) (column 9, lines 12-25). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Kim et al. and Bai et al. to enable the removing step of Kim et al. to be performed according to the teachings of Bai et al. because this would isolate the interconnect layer within the trench (column 9, lines 18 – 20) and because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed removing step of Kim et al. and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

The combined teachings of Kim et al. and Bai et al. fail to teach wherein said heat treatment is a rapid thermal anneal process performed from about 5 to 60 seconds, at a temperature from about 600°C to about 750°C. However, Teo in a related method to form interconnects teaches the step of using rapid thermal annealing to a Ti/TiN layer

at a temperature of about 670°C for about 30 seconds (column 3, lines 30 – 35 and column 4, lines 17-25). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to use a RTA process as taught by Teo and in the combination of Kim et al., Bai et al., since this improves the adhesion of the barrier layer in the contact opening (column 4, lines 17-25).

Still the combined teachings of Kim et al., Bai et al. and Teo fail to teach performing the thermal anneal from 5 to 60 seconds at a temperature from about 600°C to 750°C. However, in the case where the claimed ranges “overlap or lie inside ranges disclosed by the prior art” a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the annealing specifications disclosed in the combined teachings of Kim et al., Bai et al. and Teo to arrive at the claimed invention.

In reference to claims 5, 6, 16 and 17, the combined teachings of Kim et al., Bai et al. and Teo teach depositing a tungsten contact by chemical vapor deposition (Kim et al., column 4, line 57 – column 5, line 4).

In reference to claims 8, 9, 19, 20 and 23, Kim et al. in combination with Bai et al. teach depositing a barrier layer including forming a thickness of said barrier layer ranging from about 90 nm to about 290 nm within said contact opening having a design width below 1 μ and forming a field area thickness of said barrier layer on said semiconductor substrate of about 75 nm or greater (Kim et al., column 4, lines 38-44). Kim et al. in combination with Bai et al. fail to teach the thickness of said barrier layer from about 5 nm to about 20 nm and having 5% to about 20% of field area thickness

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within said contact opening. Notwithstanding, it would have been an obvious matter of design choice bounded by well known manufacturing constraints and ascertainable by routine experimentation and optimization to choose these particular dimensions because applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical. See, for example, *In re Rose*, 220 F.2d 459, 105 USPQ 237 (CCPA 1955); *In re Rinehart*, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976); *Gardner v. TEC Systems, Inc.*, 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), cert. denied, 469 U.S. 830, 225 USPQ 232 (1984); *In re Dailey*, 357 F.2d 669, 149 USPQ 47 (CCPA 1966).

In reference to claims 10, 11, 21 and 22, Kim et al. in combination with Bai et al. teach removing a substantial portion including removing said contact metal and said barrier layer from said field area thickness by chemical mechanical polishing processes (Kim et al., column 5, lines 62-67 and Bai et al., lines column 9, lines 12-24).

6. Claims 4 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. ('671) in view of Bai et al. ('418) as applied to claims 1, 5, 6, 8-12, 16, 17 and 19-24 above, and further in view of the applicants admitted prior art in the instant application.

Kim et al. in combination with Bai et al. teach depositing a barrier layer in a contact opening in a dielectric layer, but fail to show the contact opening with an aspect ratio ranging from about 3:1 to about 5:1. However, the prior art teaches forming openings having aspects ratios from about 3:1 to about 5:1 (page 2, lines 1-6).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to specify aspect ratios of about 3:1 to about 5:1 as taught by the prior art and include it in the combination of Kim et al. and Bai et al., since this fulfill the need for forming smaller devices (page 1, line14 - page 2, line 6).

Response to Arguments

7. Applicant's arguments filed 11/17/2003 have been fully considered but they are not persuasive.

Applicants argue, "...Kim fails to teach or suggest subjecting the contact plug to a temperature from about 600°C to about 750°C to anneal the barrier layer, as recited in Claim 1. Rather, Kim states that heat treatment is performed after forming the refractory metal 28 on barrier layer 27... Bai fails to cure the deficit teachings of Kim. For example, after forming capture layer 43 and blocking layer 42, but before depositing copper, Bai subjects these barrier layers to a high temperature anneal. (Column 8, Lines 58-64)... Performing a thermal annealing step after the deposition of metal, as done by Kim, would therefore be contrary to Bai's goal of annealing micro defects in the barrier before depositing metal on the barrier...". In response to this argument, applicants assert that Bai et al. teach an annealing step before depositing a metal contact. However, Bai et al. was relied on as disclosing a removing step (i.e., CMP

process) not an annealing step. Also, the annealing step of Bai et al. corresponds to one embodiment of the invention (Bai et al., column 8, line 58 – column 9, line 3).

Also, applicants argue, "...Teo...performs thermal annealing after the deposition of a Ti layer 16 and a TiW layer 18 (Column 4, Lines 17-25, FIG. 3A), but before the deposition of tungsten 40. Thus, Teo's process falls within the scope of Prior Art depicted in FIGURES IA and IB where rapid thermal annealing is performed before plug formation...". In response to this argument, applicants assert that Teo performs its annealing step prior to the deposition of a contact. However, Teo was relied on as disclosing using a specific annealing process, not the actual anneal process at some point in the process. Also, the purpose of the annealing step Teo is to improve the adhesion of its barrier layers (column 4, lines 22 – 25). Since, Kim et al. teach the annealing step after the deposition of the metal plug, performing the thermal annealing specifications of Teo in the process of Kim would meet the claimed invention.

Conclusion

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the


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shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

9. Any inquiry of a general nature or relating to the status of this application should be directed to the Group Receptionist whose telephone number is (703) 308-0956 until 2/4/04. See MPEP 203.08.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner George Fourson whose telephone number is (703) 308-2544 until 2/4/04 and (571) 272-1860 thereafter. The examiner can normally be reached on Monday through Friday.

11. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri, can be reached on (703) 306-2794 until 2/4/04 and (571) 272-1855 thereafter. The fax number for this group is 703-872-9306 for before final submissions, 703-872-9306 for after final submissions and the customer service number for group 2800 is (703) 306-3329. Updates can be found at <http://www.uspto.gov/web/info/2800.htm>.


George Fourson
Primary Examiner
Art Unit 2823

Julio J. Maldonado
January 20, 2004